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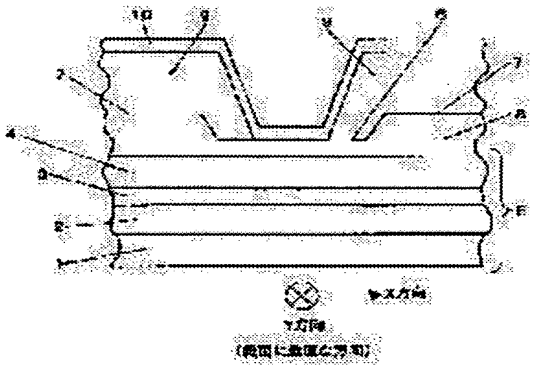
## (54) THIN-FILM MAGNETIC HEAD AND METHOD OF MANUFACTURE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a thin-film magnetic head having high sensitivity and stable reproducing performance, by supplying stable longitudinal bias and to provide a method for manufacturing the thin-film magnetic head, in a reproducing head having a narrower gap length for the purpose of reproducing a recorded signal of a short wavelength accompanying making of higher recording density.
SOLUTION: A connection magnetic field at a part connected with a part having a large film thickness of a bias antiferromagnetic film of a free magnetic layer can be strengthened and a connection magnetic field at a part connected with a part having thin-film thickness of the bias antiferromagnetic film of the free magnetic layer can be weakened by forming the bias antiferromagnetic film having a stepped part by the difference of film thickness on the free magnetic layer formed at the highest part of the magneto resistive element. Thereby, Barkhausen noise can be stably suppressed regardless of the gap length and reproducing sensitivity can be enhanced.



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* NOTICES *



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1. This document has been translated by computer.So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3.In the drawings, any words are not translated.

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CLAIMS

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[Claim(s)]
[Claim 1] The magnetoresistance-effect type thin film magnetic head which consists of a vertical bias layer which has a magnetoresistance-effect element through an insulating material, and was prepared in contact with the aforementioned magnetoresistance-effect element between the lower shield layers and up shield layers which are characterized by providing the following, and an electrode lead layer for passing the signal current. The magnetoresistance-effect element which consists of an antiferromagnetism layer, a fixed magnetic layer, a nonmagnetic conductive layer, and a free magnetic layer. The bias antiferromagnetism film which has the 1st flat surface with the level difference by the thickness difference, and the 2nd flat surface.
[Claim 2] The joint magnetic field by antiferromagnetism combination of the portion of the aforementioned free magnetic layer which is in contact with the portion of the aforementioned bias antiferromagnetism film which constitutes the 1st small flat surface of the above of thickness is 8 kA/m. Following (below 100e )
The thin film magnetic head according to claim 1 which comes out and is characterized by a certain thing.
[Claim 3] The manufacture method of the thin film magnetic head characterized by providing the following. The 1st process which carries out laminating membrane formation of an antiferromagnetism layer, a fixed magnetic layer, a non-magnetic layer, and the free magnetic layer one by one, and forms a magnetoresistance-effect element on a lower gap insulating layer. After forming a bias antiferromagnetism layer membrane so that the aforementioned magnetoresistance-effect element top may be covered, The 2nd process which forms a bias antiferromagnetism film with the level difference which consists of a portion with the small thickness which deletes a part of aforementioned bias antiferromagnetism layer membrane, and has the 1st flat surface, and a large portion of the thickness which has the 2nd flat surface, The 3rd process which deletes a part of electrode lead layer membrane at least, and forms the electrode lead layer of a right-and-left couple so that the aforementioned bias antiferromagnetism film top may be covered, an electrode lead layer membrane may be formed and a part of 1st flat surface [ at least ] of the aforementioned bias antiferromagnetism film may be exposed.
[Claim 4] the 3rd process of a claim 3 -- setting -- a 1st [ of the aforementioned bias antiferromagnetism film ] flat-surface top -- a mushroom -- the manufacture method of the thin film magnetic head according to claim 3 characterized by having the 3rd process which forms a type resist and forms the electrode lead layer of a right-and-left couple on the aforementioned bias antiferromagnetism film
[Claim 5] The 2nd process of a claim 3 and the 3rd process which are characterized by providing the following. The 2nd process which forms a bias antiferromagnetism layer membrane so that the aforementioned free magnetic layer top may be covered. Furthermore, so that a part of aforementioned bias antiferromagnetism layer membrane may be shaved off and it may expose, after forming an electrode lead layer membrane so that a it top may be covered A part of aforementioned electrode lead layer membrane and each aforementioned bias antiferromagnetism layer membrane are deleted. The upper surface of the aforementioned bias antiferromagnetism layer membrane which it was deleted and was exposed The 1st flat surface, The 3rd process which forms the electrode lead layer of a right-and-left couple on the 2nd [ of the bias antiferromagnetism film which has a level difference by the thickness difference which makes the upper surface of the aforementioned bias antiferromagnetism layer membrane at the time of membrane formation the 2nd flat surface, and the aforementioned bias antiferromagnetism film ] flat surface.
[Claim 6] The manufacture method of the thin film magnetic head characterized by providing the following. The 1st process which carries out laminating membrane formation of an antiferromagnetism layer, a fixed magnetic layer, a non-magnetic layer, and the free magnetic layer one by one, and forms a magnetoresistance-effect element on a lower gap insulating layer. So that the aforementioned free magnetic layer top which constitutes the aforementioned magnetoresistance-effect element may be covered A type resist is formed. the 1st bias antiferromagnetism film -- forming membranes -- the upper surface of the bias antiferromagnetism film of the above 1st -- a mushroom -- The upper surface which carried out membrane formation formation of the 2nd bias antiferromagnetism film of a right-and-left couple, and has exposed the bias antiferromagnetism film of the above 1st The 1st flat surface, The upper surface of the bias antiferromagnetism film of the above 2nd is made into the 2nd flat surface, and the thickness of the portion of the 1st flat surface of the above is the thickness of the bias antiferromagnetism film of the above 1st. The 2nd process which forms the bias antiferromagnetism film which whose thickness of the portion of the 2nd flat surface of the above is the sum of the thickness of the bias antiferromagnetism film of the above 1st, and the thickness of the bias antiferromagnetism film of the above 2nd, and has the level difference which has a thickness difference among them, The 3rd process which carries out membrane formation formation of the electrode lead layer of a right-and-left couple on the bias antiferromagnetism film of the above 2nd.
[Claim 7] So that the aforementioned free magnetic layer top which constitutes the aforementioned magnetoresistance-effect element may be covered in the 2nd process of a claim 6 A type resist is formed. the 1st bias antiferromagnetism film -- forming membranes -- the upper surface of the bias antiferromagnetism film of the above 1st -- a mushroom -- After cleaning the upper surface of the bias antiferromagnetism film of the above 1st, membrane formation formation of the 2nd bias antiferromagnetism film of a right-and-left couple is carried out. The 1st flat surface and the upper surface of the bias antiferromagnetism film of the above 2nd are made into the 2nd flat surface for th upper surface which has exposed the bias antiferromagnetism film of the above 1st. The manufacture method of the thin film magnetic head according to claim 6 characterized by having the 2nd process which forms a bias antiferromagnetism film with the level difference by the thickness difference between the 1st flat surface of the above, and the 2nd flat surface of the above.
[Claim 8] So that the bias antiferromagnetism film top of the above 2nd of the portion which the bias

antiferromagnetism film of the above 1st exposed, and a right-and-left couple may be covered, after deleting the resist formed at the 2nd process of the above in the 3rd process of a claim 6 So that an electrode lead layer membrane may be formed and some bias antiferromagnetism films [ at least ] of the above 1st may be exposed The manufacture method of the thin film magnetic head given in either the claim 6 characterized by deleting a part of aforementioned electrode lead layer membrane at least, and having the 3rd process which forms the electrode lead layer of a right-and-left couple, or the claim 7.

[Claim 9] the 1st flat-surface top of the bias antiferromagnetism film of the above 1st after deleting the resist formed at the 2nd process of the above in the 3rd process of a claim 6 -- a mushroom -- the manufacture method of the thin film magnetic head given in either the claim 6 characterized by having the 3rd process which forms a type resist and forms the electrode lead layer of a right-and-left couple, or the claim 7

[Claim 10] The manufacture method of the thin film magnetic head according to claim 3 to 9 characterized by having the 4th process which forms a cap layer so that the portion top which the 1st flat surface of the aforementioned electrode lead layer of the right-and-left couple formed on the aforementioned bias antiferromagnetism film which has a level difference, and the aforementioned bias antiferromagnetism film exposed may be covered.

[Claim 11] The manufacture method of the thin film magnetic head characterized by providing the following. The 1st process which carries out laminating membrane formation of an antiferromagnetism layer, a fixed magnetic layer, a non-magnetic layer, and the free magnetic layer one by one, and forms a magnetoresistance-effect element on a lower gap insulating layer. A type resist is formed. the aforementioned free magnetic layer top -- a wrap -- like -- the 1st bias antiferromagnetism film -- forming membranes -- further -- a it top -- a wrap -- the cap layer top aforementioned after forming a cap layer like -- a mushroom -- Shave off a part of aforementioned cap layer at least, and membrane formation formation of the 2nd bias antiferromagnetism film of a right-and-left couple is carried out on it so that the bias antiferromagnetism film of the above 1st may be exposed. The upper surface of the bias antiferromagnetism film of the above 1st which touched the aforementioned cap layer The 1st flat surface, The upper surface of the bias antiferromagnetism film of the above 2nd is made into the 2nd flat surface, and the thickness of the portion of the 1st flat surface of the above is the thickness of the bias antiferromagnetism film of the above 1st. The 2nd process which forms the bias antiferromagnetism film which whose thickness of the portion of the 2nd flat surface of the above is the sum of the thickness of the bias antiferromagnetism film of the above 1st, and the thickness of the bias antiferromagnetism film of the above 2nd, and has the level difference which has a thickness difference among them, The 3rd process which carries out membrane formation formation of the electrode lead layer of a right-and-left couple on the bias antiferromagnetism film of the above 2nd.

[Claim 12] the cap layer top aforementioned after deleting the resist formed at the 2nd process of the above in the 3rd process of a claim 11 -- a mushroom -- the manufacture method of the thin film magnetic head according to claim 11 characterized by forming a type resist and having the 3rd process which carries out membrane formation formation of the electrode lead layer of a right-and-left couple

[Claim 13] After deleting the resist formed at the 2nd process of the above in the 3rd process of a claim 11, so that the aforementioned bias antiferromagnetism film [ of the above 2nd ] and cap layer top may be covered So that an electrode lead layer membrane may be formed and a part of aforementioned cap layer [ at least ] may be exposed The manufacture method of the thin film magnetic head given in either the claim 11 characterized by deleting a part of aforementioned electrode lead layer membrane at least, and having the 3rd process which forms the electrode lead layer of a right-and-left couple, or the claim 12.

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[Translation done.]

## DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention is applied to the equipment which performs high-density record and reproduction to magnetic-recording media, such as a magnetic disk unit (HDD equipment), gives the bias magnetic field especially stabilized in the free magnetic layer of a magnetoresistance-effect element, and relates to the high magnetoresistance-effect type thin film magnetic head and its manufacture method of a regeneration efficiency.
[0002]
[Description of the Prior Art] In recent years, in the record and reproduction to magnetic-recording media, such as a magnetic disk unit (HDD equipment), improvement in processing speed and the need for large-capacity-izing of storage capacity are increasing, and the measure for a raise in recording density is being strengthened.
[0003] Hereafter, the conventional thin film magnetic head is explained using a drawing.
[0004] Drawing 21 and drawing 22 are drawings showing the conventional thin film magnetic head, drawing 21 is a tropia schematic diagram and drawing 22 is the transverse-plane outline diagram of the thin film magnetic head.
[0005] For example, the thin film magnetic head used for the record reproduction to the magnetic-recording medium of the signal in a magnetic disk unit has many which are called so-called MR (GMR) inductive combined head as shown in drawing 21 .
[0006] In drawing 21 , the nonmagnetic insulating material of aluminum2O3, AlN, or SiO2 grade is used on the lower shield layer 211 formed by soft magnetic materials, such as a permalloy, Co system amorphous magnetic film, or Fe system alloy magnetic film, the lower gap insulating layer 212 is formed, and it is a magnetoresistance-effect element (MR element or GMR element.) to the upper surface further. Laminating membrane formation formation of the 213 called GMR element is carried out hereafter, and the vertical bias layer 214 is formed by the right-and-left both-sides edge of the GMR element 213 with material, such as a CoPt alloy. Furthermore, the ridgeline which is a nodal line of the upper surface and the both-sides side of the GMR element 213 to make is touched, material, such as Cu, Cr, or Ta, is used for the upper surface of the vertical bias layer 214, and the electrode lead layer 215 of a right-and-left couple is formed. Here, as the upper surface of the vertical bias layer 214 and the upper surface of a part of GMR element 213 are started, you may form the electrode lead layer 205. Next, the up gap insulating layer 216 is formed on the portion which the electrode lead layer 215 and the GMR element 213 exposed using the same nonmagnetic insulating material as the lower gap insulating layer 212. Furthermore, on the up gap insulating layer 216, membrane formation formation of the up shield layer 217 is carried out using the same soft magnetic materials as the lower shield layer 211, and the magnetoresistance-effect type thin film magnetic-head section 218 for reproduction is constituted.
[0007] Next, the record gap layer 221 is formed using the same nonmagnetic insulating material as the lower gap insulating layer 212 on the upper surface of the up shield layer 217. Furthermore, the up shield layer 217 is countered through the record gap layer 221. And membrane formation formation of the up magnetic pole 222 which is in contact with the up shield layer 217 is carried out using soft magnetic materials in other portions. Between the up shield layer 217, the portion which the up magnetic pole 222 has countered, and the portion to which the up magnetic pole 222 is in contact with the up shield layer 217, through the record gap layer 221 The coil coil 223 insulated from the up shield layer 217 and the up magnetic pole 222 through the insulating material (not shown) is formed, and the induction-type thin film magnetic-head section 220 for record is constituted. Here, the up shield layer 217 has the function which combines the shield function of the magnetoresistance-effect type thin film magnetic-head section 218 for reproduction, and the lower magnetic pole function of the induction-type thin film magnetic-head section 220 for record.
[0008] By supplying record current to the coil coil 223, a record magnetic field occurs in the up magnetic pole 222 and the up shield layer 217 of the induction-type thin film magnetic-head section 220 for record, magnetic leakage flux occurs between the up magnetic poles 222 and the up shield layers 217 which counter through the record gap layer 221, and a record signal is recorded on a magnetic-recording medium. Moreover, the magnetic field of the signal recorded on the magnetic-recording medium by which the signal was recorded is reproduced in the magnetoresistance-effect type thin film magnetic-head section 218 for reproduction, and the regenerative signal according to the resistance change by the GMR element 213 is detected from the terminal of the electrode lead layer 215.
[0009] As the transverse-plane outline diagram near [ in the reproducing-head section of the thin film magnetic head ] the magnetoresistance-effect element is shown in drawing 22 On the lower gap insulating layer 212 formed by the upper surface of the lower shield layer 211 The antiferromagnetism layer 224, FeNi system alloy film which are material, such as a FeMn system alloy film and a PtMn system alloy film Laminating membrane formation of the cap layer 228 made from the non-magnetic layer 226 made from the fixed magnetic layer 225 made from a permalloy, Co, a FeCo alloy film, etc., Cu, etc., the fixed magnetic layer 225 and the free magnetic layer 227 made into the same material, Ta, etc. is carried out one by one. It is shaved off so that it may have the field where the right-and-left both-sides edge inclined at etching processes, such as ion milling, and the GMR element 213 is formed. The right-and-left both-sides end face of the GMR element 213 is touched, the vertical bias layer 214 of a right-and-left couple is formed, and the electrode lead layer 215 of a right-and-left couple is formed on it. Furthermore, on them, the up gap insulating layer 216 is formed, the up shield layer 217 is further formed on it, and the magnetoresistance-effect type thin film head for reproduction is constituted. In order to reproduce the record signal of the short wavelength corresponding to a raise in recording density in recent years, the reproduction head gap length 229 is becoming still smaller.
[0010]

[Problem(s) to be Solved by the Invention] However, in the reproducing-head section of the thin film magnetic head of the above-mentioned conventional composition, in order to reproduce the signal recorded on the magnetic-recording medium by short wavelength, it is necessary to make reproduction head gap length small. Reproduction head gap length The distance, i.e., the lower gap insulating layer, from the upper surface of a lower shield layer to the inferior surface of tongue of an up shield layer, Are the sum of each thickness of a GMR element and an up gap insulating layer, and the vertical bias layer of the right-and-left couple which making this distance small has in the both sides of a GMR element will approach a lower shield layer or an up shield layer. Although the magnetic field of a vertical bias layer becomes easy to escape in a lower shield layer or an up shield layer and a bias magnetic field starts the free magnetic layer near the vertical bias layer of a GMR element In order for a bias magnetic field to become weaker in a part for the center section of a free magnetic layer (a part for the center section of the direction of the width of recording track), and for the direction of magnetization of a free magnetic layer to become unstable, and not to obtain the regenerative signal which the noise increased and was stabilized but to obtain the stable regenerative signal Although magnetization of a free magnetic layer was stabilized and the Barkhausen noise was suppressed when the cure which strengthens a vertical bias magnetic field was performed, sensitivity fell, and the direction of magnetization of a fixed magnetic layer also inclined greatly, and had the technical problem that symmetric property got worse.
[0011] this invention solves the above-mentioned technical problem, adds the vertical bias stabilized in the free magnetic layer by the joint magnetic field combined with the antiferromagnetism film which has the level difference from which the thickness formed on the free magnetic layer of a GMR element differs in antiferromagnetism, stabilizes the direction of magnetization of a free magnetic layer, suppresses generating of a Barkhausen noise, and aims at offering the good magnetoresistance-effect type thin film magnetic head and its manufacture method of reproducibility ability.
[0012]
[Means for Solving the Problem] In order to attain this purpose, the thin film magnetic head of this invention has the composition it was made to consist of a magnetoresistance-effect element which consists of an antiferromagnetism layer, a fixed magnetic layer, a nonmagnetic conductive layer, and a free magnetic layer, and a bias antiferromagnetism film which has the 1st flat surface with the level difference by the thickness difference, and the 2nd flat surface. moreover, joint magnetic field by antiferromagnetism combination of the portion of the free magnetic layer which is in contact with the portion of the bias antiferromagnetism film with which the thin film magnetic head of this invention constitutes the 1st flat surface with small thickness 8 or less (below 100e ) kA/m it is -- having made -- it has composition
[0013] By this composition, a bias magnetic field strong against a portion (portions other than the width-of-recording-track portion of a free magnetic layer) to fix the magnetization direction to very strongly is applied. On the other hand, although a bias magnetic field must be applied in order to suppress a Barkhausen noise It becomes possible [ controlling by thickness of the antiferromagnetism film of each portion easily ] to apply the optimal bias magnetic field for a portion (width-of-recording-track portion of a free magnetic layer) not to apply a not much strong magnetic field, since reproduction sensitivity will fall if a strong magnetic field is applied. that is, to the free magnetic layer which is in contact with the antiferromagnetism film of the portion of the 2nd big flat surface of thickness The joint magnetic field by strong antiferromagnetism combination is acquired, and the direction of the magnetization becomes what was stabilized very much. The sake, Even if the joint magnetic field by antiferromagnetism combination of the portion of the free magnetic layer which is in contact with the antiferromagnetism film of the portion of the 1st small flat surface of thickness is small Become easy to be suitable in the direction of magnetization of the free magnetic layer which was stabilized and is in contact with the antiferromagnetism film of the portion of the 2nd big flat surface of thickness, and the direction of the same magnetization. Moreover, since the antiferromagnetism joint magnetic field of the portion of the free magnetic layer which is in contact with the antiferromagnetism film of the portion of the 1st small flat surface of thickness is small, By the external magnetic field, i.e., the magnetic field from a magnetic-recording medium, the direction of the magnetization becomes easy to change, there can be little generating of a Barkhausen noise, reproduction sensitivity can be high, and reproducibility ability can be stabilized. moreover, since there is no influence which is not concerned with gap length, but has the same effect, and this bias magnetic field has on a fixed magnetic layer in order to apply a bias magnetic field by the joint magnetic field with an antiferromagnetism film and the inclination of magnetization of the fixed magnetic layer by it is not produced, either, degradation of the symmetric property of an output wave is suppressed Moreover, by choosing the thickness of the antiferromagnetism film of the portion of the first flat surface the optimal, the joint magnetic field of an antiferromagnetism film and a free magnetic layer can be stabilized and given to the strength of 8 or less kA/m, and improvement in reproducibility ability can be aimed at.
[0014] Moreover, the manufacture method of the thin film magnetic head of this invention So that the 1st process which carries out laminating membrane formation of an antiferromagnetism layer, a fixed magnetic layer, a non-magnetic layer, and the free magnetic layer one by one, and forms a magnetoresistance-effect element on a lower gap insulating layer, and a magnetoresistance-effect element top may be covered The 2nd process which forms a bias antiferromagnetism film with the level difference which consists of a portion with the small thickness which deletes a part of bias antiferromagnetism layer membrane, and has the 1st flat surface after forming a bias antiferromagnetism layer membrane, and a large portion of the thickness which has the 2nd flat surface, A part of electrode lead layer membrane is deleted at least, and it has the 3rd process which forms the electrode lead layer of a right-and-left couple so that a bias antiferromagnetism film top may be covered, an electrode lead layer membrane may be formed and a part of 1st flat surface [ at least ] of a bias antiferromagnetism film may be exposed. moreover, the manufacture method of the thin film magnetic head of this invention -- a 1st [ of a bias antiferromagnetism film ] flat-surface top -- a mushroom -- it has the 3rd process which forms a type resist and forms the electrode lead layer of a right-and-left couple on a bias antiferromagnetism film Moreover, the manufacture method of the thin film magnetic head of this invention Further with the 2nd process which forms a bias antiferromagnetism layer membrane so that a it top may be covered so that a free magnetic layer top may be covered So that a part of bias antiferromagnetism layer m mbrane may be shaved off and it may expose, after forming an electrode lead layer membrane A part of electrode lead layer membrane and each bias antiferromagnetism layer membrane are delet d. The upper surface of the bias antiferromagnetism layer membrane which it was deleted and was exposed The 1st flat surface, It has the 3rd process which forms the electrode lead layer of a right-and-left couple on the 2nd [ of the bias antiferromagnetism film which has a level difference by the thickness difference which makes the upper surface of the bias antiferromagnetism layer membrane at the time of membrane formation the 2nd flat surface, and a bias antiferromagnetism film ] flat surface.

Moreover, the manufacture method of the thin film magnetic head of this invention So that the 1st process [ which carries out laminating membrane formation of an antiferromagnetism layer, a fixed magnetic layer, a non-magnetic layer, and the free magnetic layer one by one, and forms a magnetoresistance-effect element on a lower gap insulating layer ], and free magnetic layer top which constitutes a magnetoresistance-effect element may be covered A type resist is formed. the 1st bias antiferromagnetism film -- forming membranes -- the upper surface of the 1st bias antiferromagnetism film -- a mushroom -- The upper surface which carried out membrane formation formation of the 2nd bias antiferromagnetism film of a right-and-left couple, and has exposed the 1st bias antiferromagnetism film The 1st flat surface, The upper surface of the 2nd bias antiferromagnetism film is made into the 2nd flat surface, and the thickness of the portion of the 1st flat surface is the thickness of the 1st bias antiferromagnetism film. The 2nd process which forms the bias antiferromagnetism film which whose thickness of the portion of the 2nd flat surface is the sum of the thickness of the 1st bias antiferromagnetism film, and the thickness of the 2nd bias antiferromagnetism film, and has the level difference which has a thickness difference among them, On the 2nd bias antiferromagnetism film, it has the 3rd process which carries out membrane formation formation of the electrode lead layer of a right-and-left couple. Moreover, the manufacture method of the thin film magnetic head of this invention A type resist is formed. the aforementioned free magnetic layer top which constitutes a magnetoresistance-effect element -- a wrap -- like -- the 1st bias antiferromagnetism film -- forming membranes -- the upper surface of the 1st bias antiferromagnetism film -- a mushroom -- After cleaning the upper surface of the 1st bias antiferromagnetism film, membrane formation formation of the 2nd bias antiferromagnetism film of a right-and-left couple is carried out. The 1st flat surface and the upper surface of the 2nd bias antiferromagnetism film are made into the 2nd flat surface for the upper surface which has exposed the 1st bias antiferromagnetism film, and it has the 2nd process which forms a bias antiferromagnetism film with the level difference by the thickness difference between the 1st flat surface and the 2nd flat surface. Moreover, the manufacture method of the thin film magnetic head of this invention So that the 2nd bias antiferromagnetism film top of the portion which the 1st bias antiferromagnetism film exposed, and a right-and-left couple may be covered, after deleting the resist formed at the 2nd process of the above A part of electrode lead layer membrane is deleted at least, and it has the 3rd process which forms the electrode lead layer of a right-and-left couple so that an electrode lead layer membrane may be formed and a part of 1st bias antiferromagnetism film [ at least ] may be exposed. moreover, the 1st flat-surface top of the 1st [ after the manufacture method of the thin film magnetic head of this invention deletes the resist formed at the 2nd process ] bias antiferromagnetism film -- a mushroom -- it has the 3rd process which forms a type resist and forms the electrode lead layer of a right-and-left couple Moreover, the manufacture method of the thin film magnetic head of this invention has the 4th process which forms a cap layer so that the portion top which the 1st flat surface of the electrode lead layer of the right-and-left couple formed on the bias antiferromagnetism film which has a level difference, and a bias antiferromagnetism film exposed may be covered. Moreover, the manufacture method of the thin film magnetic head of this invention On a lower gap insulating layer, laminating membrane formation of an antiferromagnetism layer, a fixed magnetic layer, a non-magnetic layer, and the free magnetic layer is carried out one by one. A type resist is formed. the 1st process which forms a magnetoresistance-effect element, and a free magnetic layer top -- a wrap -- like -- the 1st bias antiferromagnetism film -- forming membranes -- further -- a it top -- a wrap -- the cap layer top after forming a cap layer like -- a mushroom -- Shave off a part of cap layer at least, and membrane formation formation of the 2nd bias antiferromagnetism film of a right-and-left couple is carried out on it so that the 1st bias antiferromagnetism film may be exposed. The upper surface of the 1st bias antiferromagnetism film which touched the cap layer The 1st flat surface, The upper surface of the 2nd bias antiferromagnetism film is made into the 2nd flat surface, and the thickness of the portion of the 1st flat surface is the thickness of the 1st bias antiferromagnetism film. The 2nd process which forms the bias antiferromagnetism film which whose thickness of the portion of the 2nd flat surface is the sum of the thickness of the 1st bias antiferromagnetism film, and the thickness of the 2nd bias antiferromagnetism film, and has the level difference which has a thickness difference among them, On the 2nd bias antiferromagnetism film, it has the 3rd process which carries out membrane formation formation of the electrode lead layer of a right-and-left couple. moreover, the cap layer top after the manufacture method of the thin film magnetic head of this invention deletes the resist formed at the 2nd process -- a mushroom -- a type resist is formed and it has the 3rd process which carries out membrane formation formation of the electrode lead layer of a right-and-left couple Moreover, after the manufacture method of the thin film magnetic head of this invention deletes the resist formed at the 2nd process, it deletes a part of electrode lead layer membrane at least, and has the 3rd process which forms the electrode lead layer of a right-and-left couple so that a 2nd bias antiferromagnetism film and cap layer top may be covered, an electrode lead layer membrane may be formed and a part of cap layer [ at least ] may be exposed.

[0015] By forming the antiferromagnetism film which has a level difference by the thickness difference by this method on a free magnetic layer A bias magnetic field strong against a portion (portions other than the width-of-recording-track portion of a free magnetic layer) to fix the magnetization direction to very strongly is applied. On the other hand, although a bias magnetic field must be applied in order to suppress a Barkhausen noise Applying the optimal bias magnetic field for a portion (the direction center section of the width of recording track of the free magnetic layer) not applying a not much strong magnetic field, since reproduction sensitivity will fall if a strong magnetic field is applied The magnetoresistance-effect type thin film magnetic head which can be easily controlled by thickness of the antiferromagnetism film of each portion is producible. That is, although the free magnetic layer which is in contact with the big portion of thickness on either side was combined by the joint magnetic field by very strong antiferromagnetism combination, the free magnetic layer is [ near the head truck section / on the other hand ] in contact with the small antiferromagnetism film of thickness and it is combined by the comparatively small antiferromagnetism joint magnetic field The direction of the magnetization will be turned to in the same direction as the big antiferromagnetism film of thickness, and the direction of the magnetization of a free magnetic layer which has the joint magnetic field by strong antiferromagnetism combination. The direction of the magnetization stabilized very much is obtained, and the magnetoresistance-effect type thin film head of high reproducibility ability with high reproduction sensitivity with few noises can be produced. Furthermore, on the 1st antiferromagnetism film with which the upper surface was cleaned, since membrane formation formation of the 2nd antiferromagnetism film is carried out, between the 1st antiferromagnetism film and the 2nd antiferromagnetism film, very good adhesion and a magnetic combination are stabilized, and are obtained, and the magnetoresistance-effect type thin film magnetic head by which the direction of magnetization of a free magnetic layer was stabilized very much can be produced. Moreover, by forming a cap layer, oxidization on the upper surface of an antiferromagnetism film can be prevented; corrosion resistance can also improve, and property degradation by them can produce the magnetoresistance-effect type thin film magnetic head which was

excellent in few reproducibility ability.
[0016]
[Embodiments of the Invention] The vertical bias layer which invention of this invention according to claim 1 has a magnetoresistance-effect element through an insulating material between a lower shield layer and an up shield layer, and was prepared in contact with the aforementioned magnetoresistance-effect element, In the magnetoresistance-effect type thin film magnetic head which consists of an electrode lead layer for passing the signal current The magnetoresistance-effect element which consists of an antiferromagnetism layer, a fixed magnetic layer, a nonmagnetic conductive layer, and a free magnetic layer, It is characterized by having the composition which consists of a bias antiferromagnetism film which has the 1st flat surface with the level difference by the thickness difference, and the 2nd flat surface. moreover, invention of this invention according to claim 2 joint magnetic field by antiferromagnetism combination of the portion of the free magnetic layer which is in contact with the portion of the bias antiferromagnetism film which constitutes the 1st small flat surface of thickness 8 kA/m The following (below 100e ) It is characterized by things. it is -- A bias magnetic field strong against a portion (portions other than the width-of-recording-track portion of a free magnetic layer) to fix the magnetization direction to very strongly is applied. On the other hand, although a bias magnetic field must be applied in order to suppress a Barkhausen noise It becomes possible [ controlling by thickness of the antiferromagnetism film of each portion easily ] to apply the optimal bias magnetic field for a portion (the direction center section of the width of recording track of the free magnetic layer) not to apply a not much strong magnetic field, since reproduction sensitivity will fall if a strong magnetic field is applied. that is, to the free magnetic layer which is in contact with the antiferromagnetism film of the portion of the 2nd big flat surface of thickness The joint magnetic field by strong antiferromagnetism combination is acquired, and the direction of the magnetization becomes what was stabilized very much. The sake, Even if the joint magnetic field by antiferromagnetism combination of the portion of the free magnetic layer which is in contact with the antiferromagnetism film of the portion of the 1st small flat surface of thickness is small Become easy to be suitable in the direction of magnetization of the free magnetic layer which was stabilized and is in contact with the antiferromagnetism film of the portion of the 2nd big flat surface of thickness, and the direction of the same magnetization. Moreover, since the antiferromagnetism joint magnetic field of the portion of the free magnetic layer which is in contact with the antiferromagnetism film of the portion of the 1st small flat surface of thickness is small, By the external magnetic field, i.e., the magnetic field from a magnetic-recording medium, the direction of the magnetization becomes easy to change, there can be little generating of a Barkhausen noise, reproduction sensitivity can be high, and reproducibility ability can be stabilized. moreover, since there is no influence which is not concerned with gap length, but has the same effect, and this bias magnetic field has on a fixed magnetic layer in order to apply a bias magnetic field by the joint magnetic field with an antiferromagnetism film and the inclination of magnetization of the fixed magnetic layer by it is not produced, either, degradation of the symmetric property of an output wave is suppressed Moreover, by choosing the thickness of the antiferromagnetism film of the portion of the first flat surface the optimal, the joint magnetic field of an antiferromagnetism film and a free magnetic layer can be stabilized and given to the strength of 8 or less kA/m, and it has the operation that improvement in reproducibility ability can be aimed at.
[0017] Moreover, invention of this invention according to claim 3 carries out laminating membrane formation of an antiferromagnetism layer, a fixed magnetic layer, a non-magnetic layer, and the free magnetic layer one by one on a lower gap insulating layer. So that the 1st process which forms a magnetoresistance-effect element, and a magnetoresistance-effect element top may be covered The 2nd process which forms a bias antiferromagnetism film with the level difference which consists of a portion with the small thickness which deletes a part of bias antiferromagnetism layer membrane, and has the 1st flat surface after forming a bias antiferromagnetism layer membrane, and a large portion of the thickness which has the 2nd flat surface, So that a bias antiferromagnetism film top may be covered and a part of 1st flat surface [ at least ] of a bias antiferromagnetism film may be [ an electrode lead layer membrane may be formed and ] exposed A part of electrode lead layer membrane is deleted at least, and it is characterized by having the 3rd process which forms the electrode lead layer of a right-and-left couple. moreover, invention of this invention according to claim 4 A type resist is formed. the 3rd process of a claim 3 -- setting -- a 1st [ of a bias antiferromagnetism film ] flat-surface top -- a mushroom -- It is characterized by having the 3rd process which forms the electrode lead layer of a right-and-left couple on a bias antiferromagnetism film. moreover, invention of this invention according to claim 5 In the 2nd process of a claim 3, and the 3rd process, so that a free magnetic layer top may be covered With the 2nd process which forms a bias antiferromagnetism layer membrane, further, so that a it top may be covered So that a part of bias antiferromagnetism layer membrane may be shaved off and it may expose, after forming an electrode lead layer membrane A part of electrode lead layer membrane and each bias antiferromagnetism layer membrane are deleted. The upper surface of the bias antiferromagnetism layer membrane which it was deleted and was exposed The 1st flat surface, It is characterized by having the 3rd process which forms the electrode lead layer of a right-and-left couple on the 2nd [ of the bias antiferromagnetism film which has a level difference by the thickness difference which makes the upper surface of the bias antiferromagnetism layer membrane at the time of membrane formation the 2nd flat surface, and a bias antiferromagnetism film ] flat surface. again Invention of this invention according to claim 6 carries out laminating membrane formation of an antiferromagnetism layer, a fixed magnetic layer, a non-magnetic layer, and the free magnetic layer one by one on a lower gap insulating layer. So that the 1st process [ which forms a magnetoresistance-effect element ], and free magnetic layer top which constitutes a magnetoresistance-effect element may be covered A type resist is formed. the 1st bias antiferromagnetism film -- forming membranes -- the upper surface of the 1st bias antiferromagnetism film -- a mushroom -- The upper surface which carried out membrane formation formation of the 2nd bias antiferromagnetism film of a right-and-left couple, and has exposed the 1st bias antiferromagnetism film The 1st flat surface, The upper surface of the 2nd bias antiferromagnetism film is made into the 2nd flat surface, and the thickness of the portion of the 1st flat surface is the thickness of the 1st bias antiferromagnetism film. The 2nd process which forms the bias antiferromagnetism film which whose thickness of the portion of the 2nd flat surface is the sum of the thickness of the 1st bias antiferromagnetism film, and the thickness of the 2nd bias antiferromagnetism film, and has the level difference which has a thickness difference among them, It is characterized by having the 3rd process which carries out membrane formation formation of the electrode lead layer of a right-and-left couple on the 2nd bias antiferromagnetism film. moreover, invention of this invention according to claim 8 So that the 2nd bias antiferromagnetism film top of the portion which the 1st bias antiferromagnetism film exposed, and a right-and-left couple may be covered, after deleting the resist formed at the 2nd process in the 3rd process of a claim 6 So that an electrode lead layer membrane may be formed and a part of 1st bias antiferromagnetism film [ at least ] may be exposed A part of electrode lead layer

membrane is deleted at least, and it is characterized by having the 3rd process which forms the electrode lead layer of a right-and-left couple. moreover, invention of this invention according to claim 9 A type resist is formed. the 1st flat-surface top of the 1st [ after deleting the resist formed at the 2nd process in the 3rd process of a claim 6 ] bias antiferromagnetism film -- a mushroom -- It is characterized by having the 3rd process which forms the electrode lead layer of a right-and-left couple. A bias magnetic field strong against a portion (portions other than the width-of-recording-track portion of a free magnetic layer) to fix the magnetization direction to very strongly is applied. On the other hand, although a bias magnetic field must be applied in order to suppress a Barkhausen noise Applying the optimal bias magnetic field for a portion (the direction center section of the width of recording track of the free magnetic layer) not applying a not much strong magnetic field, since reproduction sensitivity will fall if a strong magnetic field is applied The magnetoresistance-effect type thin film magnetic head which can be easily controlled by thickness of the antiferromagnetism film of each portion is producible. That is, by forming the antiferromagnetism film which has a level difference by the thickness difference on a free magnetic layer Although the free magnetic layer which is in contact with the big portion of thickness on either side is combined by the joint magnetic field by very strong antiferromagnetism combination, and the free magnetic layer is [ near the head truck section ] in contact with the small antiferromagnetism film of thickness on the other hand and it is combined by the comparatively small antiferromagnetism joint magnetic field The direction of the magnetization will be turned to in the same direction as the big antiferromagnetism film of thickness, and the direction of the magnetization of a free magnetic layer which has the joint magnetic field by strong antiferromagnetism combination. The direction of the magnetization stabilized very much is obtained, and it has the operation that the magnetoresistance-effect type thin film head of high reproducibility ability with high reproduction sensitivity with few noises is producible.

[0018] Moreover, invention of this invention according to claim 7 is set at the 2nd process of a claim 6. A type resist is formed. the free magnetic layer top which constitutes a magnetoresistance-effect element -- a wrap -- like -- the 1st bias antiferromagnetism film -- forming membranes -- the upper surface of the 1st bias antiferromagnetism film -- a mushroom -- After cleaning the upper surface of the 1st bias antiferromagnetism film, membrane formation formation of the 2nd bias antiferromagnetism film of a right-and-left couple is carried out. The 1st flat surface and the upper surface of the 2nd bias antiferromagnetism film are made into the 2nd flat surface for the upper surface which has exposed the 1st bias antiferromagnetism film. By being characterized by having the 2nd process which forms a bias antiferromagnetism film with the level difference by the thickness difference between the 1st flat surface and the 2nd flat surface, and forming the antiferromagnetism film which has a level difference by the thickness difference on a free magnetic layer The direction of the magnetization stabilized very much in the free magnetic layer will be obtained, and since membrane formation formation of the 2nd antiferromagnetism film is carried out on the 1st antiferromagnetism film with which the upper surface was cleaned, further between the 1st antiferromagnetism film and the 2nd antiferromagnetism film Very good adhesion and a magnetic combination are stabilized, and are obtained, the direction of magnetization of a free magnetic layer becomes what was stabilized very much, and it has the operation that the magnetoresistance-effect type thin film head of high reproducibility ability with high reproduction sensitivity with few noises is producible.

[0019] Moreover, invention of this invention according to claim 10 so that the portion top which the 1st flat surface of the electrode lead layer of the right-and-left couple formed on the bias antiferromagnetism film which has a level difference, and a bias antiferromagnetism film exposed may be covered It is characterized by having the 4th process which forms a cap layer. moreover, invention of this invention according to claim 11 On a lower gap insulating layer, laminating membrane formation of an antiferromagnetism layer, a fixed magnetic layer, a non-magnetic layer, and the free magnetic layer is carried out one by one. A type resist is formed. the 1st process which forms a magnetoresistance-effect element, and a free magnetic layer top -- a wrap -- like -- the 1st bias antiferromagnetism film -- forming membranes -- further -- a it top -- a wrap -- the cap layer top after forming a cap layer like -- a mushroom -- Shave off a part of cap layer at least, and membrane formation formation of the 2nd bias antiferromagnetism film of a right-and-left couple is carried out on it so that the 1st bias antiferromagnetism film may be exposed. The upper surface of the 1st bias antiferromagnetism film which touched the cap layer The 1st flat surface, The upper surface of the 2nd bias antiferromagnetism film is made into the 2nd flat surface, and the thickness of the portion of the 1st flat surface is the thickness of the 1st bias antiferromagnetism film. The 2nd process which forms the bias antiferromagnetism film which whose thickness of the portion of the 2nd flat surface is the sum of the thickness of the 1st bias antiferromagnetism film, and the thickness of the 2nd bias antiferromagnetism film, and has the level difference which has a thickness difference among them, It is characterized by having the 3rd process which carries out membrane formation formation of the electrode lead layer of a right-and-left couple on the 2nd bias antiferromagnetism film. moreover, invention of this invention according to claim 12 A type resist is formed. the cap layer top after deleting the resist formed at the 2nd process in the 3rd process of a claim 11 -- a mushroom -- It is characterized by having the 3rd process which carries out membrane formation formation of the electrode lead layer of a right-and-left couple. moreover, invention of this invention according to claim 13 After deleting the resist formed at the 2nd process in the 3rd process of a claim 11, so that a 2nd bias antiferromagnetism film and cap layer top may be covered So that an electrode lead layer membrane may be formed and a part of cap layer [ at least ] may be exposed By deleting a part of electrode lead layer membrane at least, being characterized by having the 3rd process which forms the electrode lead layer of a right-and-left couple, and forming the antiferromagnetism film which has a level difference by the thickness difference on a free magnetic layer By obtaining the direction of the magnetization stabilized very much in the free magnetic layer, and forming a cap layer on the portion which has exposed the bias antiferromagnetism film further at least Oxidization of the portion which the bias antiferromagnetism film exposed can be prevented, corrosion resistance can be raised, and it has the operation that there is little property degradation by them and it can produce the magnetoresistance-effect type thin film head of high reproducibility ability with high reproduction sensitivity with few noises.

[0020] Hereafter, the gestalt of operation of this invention is explained using a drawing.

[0021] (Gestalt 1 of operation) Drawing 1 and drawing 2 are outline explanatory drawings showing the outline of the gestalt 1 of operation of this invention, and the transverse-plane outline diagram which looked at drawing 1 from the head sliding-surface side which counters a magnetic-recording medium, and drawing 2 are some transverse-plane outline diagrams of the thin film magnetic head seen from the head sliding-surface side which counters a magnetic-recording medium.

[0022] On the lower gap insulating layer (not shown) using the nonmagnetic insulating material of aluminum2O3 formed in drawing 1 on lower shield layer (not shown) made from soft magnetic materials, such as permalloy, Co system

amorphous magnetic-film, or Fe system particle magnetic film, AlN, or SiO2 grade The antiferromagnetism layer 1, NiFe system alloy film which are material, such as IrMn, alphaFe2O4, NiO, a FeMn system alloy film, and a PtMn system alloy film The magnetoresistance-effect element 5 (MR element or GMR element.) which consisted of a non-magnetic layer 3 and the fixed magnetic layer 2 made from the fixed magnetic layer 2 made from Co, a CoFe alloy film, etc., Cu, etc., and a free magnetic layer 4 made from the same ferromagnetic material a following and GMR element -- saying -- it is constituted Furthermore, the bias antiferromagnetism film 8 is formed using the antiferromagnetism material (it is better not to use a metal oxide film depending on the case) of different species [ layer / antiferromagnetism / 1 ] having / and / the level difference which has the 1st flat surface 6 and the 2nd flat surface 7 in the upper surface of the free magnetic layer 4 at the topmost part which constitutes the GMR element 5 when thickness differs. Furthermore, the electrode lead layer 9 of a right-and-left couple is formed on the bias antiferromagnetism film 8.

[0023] In addition, it is desirable to form the cap layer 10 by being made from non-magnetic materials, such as Ta, to prevent oxidization of the portion which the bias antiferromagnetism film 8 exposed, and to raise corrosion resistance on the portion which has exposed the electrode lead layer 9 of a right-and-left couple and the bias antiferromagnetism film 8.

[0024] As for each heat treatment (annealing processing) to the antiferromagnetism layer 1 or the bias antiferromagnetism film 8 which adds the direction of magnetization to each of the fixed magnetic layer 2 or the free magnetic layer 4, it is good to carry out, after the cap layer 10 is formed, and before patterning of the cap layer 10, the electrode lead layer 9, and the bias antiferromagnetism film 8 is carried out to a predetermined configuration and they are shaved off. Moreover, the heat treatment conditions of the bias antiferromagnetism film 8 for adding the direction of magnetization to the heat treatment conditions and free magnetic layer of the antiferromagnetism layer 1 for setting the direction of magnetization as the fixed magnetic layer 2 must select each material of the antiferromagnetism layer 1 and the bias antiferromagnetism film 8 so that at least one conditions of magnetic field strength, heat treatment temperature, and heat treatment time may differ.

[0025] The fixed magnetic layer 2 carries out antiferromagnetism combination strongly with the antiferromagnetism layer 1, and the direction of the magnetization is being strongly fixed in the direction (direction right-angled in space) of Y by the joint magnetic field. On the other hand, although it is magnetized so that the free magnetic layer 4 may be combined by the joint magnetic field by the bias antiferromagnetism film 8 and antiferromagnetism combination which have a level difference by the thickness difference on the upper surface and the direction of the magnetization may become in the direction of X (the direction of the width of recording track) The portion of the free magnetic layer 4 which the joint magnetic field strength by the antiferromagnetism combination will differ, and is in contact with the bias antiferromagnetism film 8 of the portion of the 1st small flat surface 6 of thickness with the thickness of the bias antiferromagnetism film 8, In the portion of the free magnetic layer 4 which is in contact with the bias antiferromagnetism film 8 of the portion of the 2nd large flat surface 7 of thickness, a difference arises in the joint magnetic field strength. It has the property that it will be saturated if the joint magnetic field also becomes large and generally becomes beyond a certain range as thickness becomes large, and the change property changes with material of the bias antiferromagnetism film 8.

[0026] Drawing 3 is drawing which carried out the simulation of the relation of a reproduction output to the joint magnetic field strength concerning a free magnetic layer, as compared with the case where the magnetic field strength added to the free magnetic layer is very strong, the direction when small is very high and a reproduction output understands a bird clapper. Especially, the output is improving rapidly [kA / 8 //m / or less (100 or less Oes) ].

[0027] Therefore, it sets into the portion of the free magnetic layer 4 which is in contact with the bias antiferromagnetism film 8 of the portion of the 1st small flat surface 6 of thickness. The heat treatment conditions which give the direction of magnetization to the 1st plane thickness and plane free magnetic layer of a portion of a bias antiferromagnetism film (in the strength of a magnetic field) When setting up suitably heat treatment temperature and heat treatment time and making it the joint magnetic field by the antiferromagnetism combination with a bias antiferromagnetism film and the free magnetic layer of the portion of the 1st flat surface become 8 or less (100 or less Oes) kA/m, a high reproduction output can be obtained.

[0028] Moreover, the fixed magnetic layer 2 which constitutes the GMR element 5 may be the laminating fixed magnetic layer 24 which has the composition by which laminating membrane formation of the 1st fixed magnetic layer film 21, the non-magnetic layer film 22, and the 2nd fixed magnetic layer film 23 was carried out on the antif rromagnetism layer 1, as shown in drawing 2 (a). At this time, the direction of magnetization of the 1st fixed magnetic layer film 21 which counters through the non-magnetic layer film 22 by the thickness of the non-magnetic layer film 22 which intervenes between the 1st fixed magnetic layer film 21 and the 2nd fixed magnetic layer film 23, and the 2nd fixed magnetic layer film 23 becomes in the respectively same direction, or becomes each other in the reverse direction.

[0029] Moreover, as shown in drawing 2 (b), the free magnetic layer 4 which constitutes the GMR element 5 The same material as the free magnetic layer 4 is used. The 1st free magnetic layer film 25, the 2nd free magnetic layer film 26, ....., The material of the free magnetic layer film which laminating membrane formation is carried out one by one with the n-th free magnetic layer film 27, and adjoins each other cannot be overemphasized by that the laminating free magnetic layer 28 currently formed by each using a material of a different kind is sufficient.

[0030] In addition, in the gestalt 1 of this operation, although the so-called GMR element using nonmagnetic electric conduction material, such as Cu, as a non-magnetic layer which constitutes a magnetoresistance-effect element has been explained, it is needless to say that the composition of an electrode lead layer etc. can be changed also to the so-called TMR element using the nonmagnetic insulating material of aluminum2O3 grade as a non-magnetic layer, and this invention can be applied.

[0031] According to the gestalt 1 of this operation, a bias magnetic field strong against a portion (portions other than the width-of-recording-track portion of a free magnetic layer) to fix the magnetization direction to very strongly is applied as mentioned above. On the other hand, although a bias magnetic field must be applied in order to suppress a Barkhausen noise It becomes possible [ controlling by thickness of the antiferromagnetism film of each portion easily ] to apply the optimal bias magnetic field for a portion (width-of-recording-track portion of a free magnetic layer) not to apply a not much strong magnetic field, since reproduction sensitivity will fall if a strong magnetic field is applied. that is, to the free magnetic layer which is in contact with the antiferromagnetism film of the portion of the 2nd big flat surface of thickness The joint magnetic field by strong antiferromagnetism combination is acquired, and the direction of the magnetization becomes what was stabilized very much. The sake, Even if the joint magnetic field by antiferromagnetism combination of the portion of the free magnetic layer which is in contact with the

antiferromagnetism film of the portion of the 1st small flat surface of thickness is small Become easy to be suitable in the direction of magnetization of the free magnetic layer which was stabilized and is in contact with the antiferromagnetism film of the portion of the 2nd big flat surface of thickness, and the direction of the same magnetization. Moreover, since the antiferromagnetism joint magnetic field of the portion of the free magnetic layer which is in contact with the antiferromagnetism film of the portion of the 1st small flat surface of thickness is small, By the external magnetic field, i.e., the magnetic field from a magnetic-recording medium, the direction of the magnetization becomes easy to change, there can be little generating of a Barkhausen noise, reproduction sensitivity can be high, and reproducibility ability can be stabilized. moreover, since there is no influence which is not concerned with gap length, but has the same effect, and this bias magnetic field has on a fixed magnetic layer in order to apply a bias magnetic field by the joint magnetic field with a bias antiferromagnetism film and the inclination of magnetization of the fixed magnetic layer by it is not produced, either, degradation of the symmetric property of an output wave is suppressed Moreover, by choosing the thickness of the antiferromagnetism film of the portion of the first flat surface the optimal, the joint magnetic field of an antiferromagnetism film and a free magnetic layer can be stabilized and given to the strength of 8 or less kA/m, and improvement in reproducibility ability can be aimed at.

[0032] Moreover, between two fixed magnetic layer films which counter through a non-magnetic layer film by stabilizing the direction of the magnetization by the joint magnetic field with an antiferromagnetism layer very much, and choosing the thickness of a non-magnetic layer film in the suitable range by making it a laminating fixed magnetic layer It can be made to join together strongly in antiferromagnetism, the direction of magnetization is fixed strongly, and the direction of each other magnetization becomes in the reverse direction, the leakage magnetic field by end-face magnetic charge is suppressed, and the direction of the magnetization in an end face also becomes what was stabilized very much.

[0033] (Form 2 of operation) Drawing 4 - drawing 11 are outline explanatory drawings showing the form 2 of operation of this invention, are process outline explanatory drawing for explaining the manufacturing process of the magnetoresistance-effect type thin film magnetic head for reproduction, and are the outline cross section which made it the cross section near the head sliding surface which counters a magnetic-recording medium in respect of being parallel to a head sliding surface. Hereafter, the manufacture method of the magnetoresistance-effect type thin film magnetic head for reproduction is explained in order of each process using a drawing.

[0034] As shown in drawing 4 , membranes are formed on the substrate 40 made from AlTiC etc., and the nonmagnetic insulating material of aluminum2O3, AlN, or SiO2 grade is used on the lower shield layer 41 made from soft magnetic materials, such as a permalloy, Co system amorphous magnetic film, or Fe system particle magnetic film, and the lower gap insulating layer 42 is formed.

[0035] As shown in drawing 5 (a), as the 1st process next, on the lower gap insulating layer 42 As the antiferromagnetism layer 51 is formed using material, such as IrMn, alphaFe2O3, NiO, a FeMn system alloy film, a NiMn system alloy film, or a PtMn system alloy film, and it is further shown in drawing 5 (b) Moreover, the fixed magnetic layer 52 is formed by being made from a NiFe system alloy film, Co, or a CoFe alloy film. Next, as shown in drawing 5 (c), the non-magnetic layer 53 made from Cu etc. is formed on the fixed magnetic layer 52. Furthermore, as shown in drawing 5 (d), on a non-magnetic layer 53, the free magnetic layer 54 is formed using the same material as the fixed magnetic layer 52, and the GMR element 55 by which laminating membrane formation of the antiferromagnetism layer 51, the fixed magnetic layer 52, a non-magnetic layer 53, and the free magnetic layer 54 was carried out one by one by the thin film is formed.

[0036] Antiferromagnetism material of different species [ layer / antiferromagnetism / 51 / which constitutes the GMR element 55 on the GMR element 55 as the 2nd process as shown in drawing 6 (a) ] (however, depending on the case) alphaFe2 -- the way which does not use metal oxide material, such as O3 and NiO, -- being good, as shown in drawing 6 (b), after using and forming the bias antiferromagnetism layer membrane 61 [ near the portion which forms, the abbreviation center section, i.e., the head width of recording track, of the GMR element 55 and the bias antiferromagnetism layer membrane 61, ] Apply a photoresist and a part of bias antiferromagnetism layer membrane 61 is shaved off by methods, such as dry etching. The antiferromagnetism film 64 with the level difference which has the 2nd large flat surface 63 of the thickness the 1st flat surface 62 to which it is shaved off and thickness is small, and right and left are not shaved [ thickness ] is formed.

[0037] As the 3rd process, as are shown in drawing 7 (a), and the electrode lead layer membrane 71 is formed on the bias antiferromagnetism film 64 with a level difference using non-magnetic materials, such as Cu, Cr, or Ta, and it is shown in drawing 7 (b) A photoresist is applied, by methods, such as dry etching, a part of electrode lead layer membrane 71 is shaved off at least, and the electrode lead layer 72 of a right-and-left couple is formed so that a part of 1st flat surface 62 of the small portion of the thickness of the bias antiferromagnetism film 64 may be exposed. As the 4th process, as shown in drawing 8 , on the portion which a part of 1st flat surface 62 of the electrode lead layer 72 of a right-and-left couple and the bias antiferromagnetism film 64 exposed, material, such as Ta, is used and the cap layer 81 is formed.

[0038] Next, although not illustrated, carry out patterning of the cap layer 81, the electrode lead layer 72 of a right-and-left couple, and the bias antiferromagnetism film 64 to a predetermined configuration, and they are shaved off. Furthermore, on them, an up gap insulating layer is formed using the same insulating material as the lower gap insulating layer 42, further, on it, membrane formation formation of the up shield layer is carried out using the same soft magnetic materials as the lower shield layer 41, and the magnetoresistance-effect type thin film magnetic head for reproduction is produced.

[0039] As shown in drawing 9 (a), as the 1st above-mentioned process moreover, on the lower gap insulating layer 42 The antiferromagnetism layer 51 is formed. on it further A NiFe system alloy film, Laminating membrane formation of the 1st non-magnetic layer film 902 and the 1st fixed magnetic layer film 901 using the non-magnetic materials made from Co or the CoFe alloy film, such as the 1st fixed magnetic layer film 901 and Ru, and the 2nd fixed magnetic layer film 903 using the same material is carried out one by one. The laminating fixed magnetic layer 91 is formed, on it, the non-magnetic layer 53 made from Cu etc. and the free magnetic layer 54 using the material of the 1st fixed magnetic layer film 901 grade and the same material may be formed one by one, and the GMR element 92 may be formed.

[0040] As shown in drawing 9 (b), as the 1st above-mentioned process moreover, on the lower gap insulating layer 42 The antiferromagnetism layer 51, the fixed magnetic layer 52, and a non-magnetic layer 53 are formed one by one. further Laminating membrane formation of the 1st free magnetic layer film 911, the 2nd free magnetic layer film 912, ....., the n-th free magnetic layer film 913 (n is two or more positive integers) may be carried out one by one on it, the laminating free magnetic layer 93 may be formed, and the GMR element 94 may be formed.

[0041] moreover, when the equipment which carries out laminating membrane formation and forms the GMR element 55

at the 1st process differs from the equipment which forms the bias antiferromagnetism layer membrane 61 at the 2nd process After cleaning the upper surface of the free magnetic layer 54 by methods, such as a pulley spatter by Ar etc., or efficient consumer response, as the 2nd process and removing an oxide film, a foreign matter, or dirt of the free magnetic layer 54 on top etc., as shown in drawing 6 It is more desirable to have formed the bias antiferromagnetism layer membrane 61 and to form the bias antiferromagnetism film 64 with the level difference which shaves off a part of bias antiferromagnetism layer membrane 61, and has a thickness difference by methods, such as dry etching. There is no mediation of a foreign matter between the free magnetic layer 54 and the bias antiferromagnetism film 64 by cleaning the upper surface of the free magnetic layer 54 at this time, and the joint magnetic field stabilized more can be acquired, without the joint magnetic field strength of the bias antiferromagnetism film 64 and the free magnetic layer 54 falling, since very good adhesion and a magnetic combination are stabilized and are obtained.
[0042] moreover, the 3rd above-mentioned process is shown in drawing 10 -- as -- the 1st flat-surface 62 top of the bias antiferromagnetism film 64 -- a mushroom -- the type resist 101 may be formed and membrane formation formation of the electrode lead layer 102 of a right-and-left couple may be carried out on the bias antiferromagnetism film 64
[0043] Moreover, in the 2nd process and the 3rd process, as shown in drawing 6 (a) like the 2nd above-mentioned process as the 2nd process After forming the bias antiferromagnetism layer membrane 61 so that the free magnetic layer 54 top may be covered, as shown in drawing 11 (a), as the 3rd process Furthermore, as the electrode lead layer membrane 111 is formed and it is shown in drawing 11 (b) so that a it top may be covered Apply a photoresist and a part of electrode lead layer membrane 111 and bias antiferromagnetism layer membrane 61 are shaved off by methods, such as dry etching. You may form the electrode lead layer 115 of a right-and-left couple on the 2nd flat surface 113 of the bias antiferromagnetism film 114 with a level difference with which the thickness of a center section has the 1st small flat surface 112, and has the 2nd large flat surface 113 of thickness right and left, and the bias antiferromagnetism film 114. In addition, before forming the bias antiferromagnetism layer membrane 61, it cannot be overemphasized that the upper surface of the free magnetic layer 54 may be cleaned.
[0044] According to the gestalt 2 of this operation, a bias magnetic field strong against a portion (portions other than the width-of-recording-track portion of a free magnetic layer) to fix the magnetization direction to very strongly is applied as mentioned above. On the other hand, although a bias magnetic field must be applied in order to suppress a Barkhausen noise Applying the optimal bias magnetic field for a portion (width-of-recording-track portion of a free magnetic layer) not applying a not much strong magnetic field, since reproduction sensitivity will fall if a strong magnetic field is applied The magnetoresistance-effect type thin film magnetic head which can be easily controlled by thickness of the antiferromagnetism film of each portion is producible. That is, the joint magnetic field of a bias antiferromagnetism film and a free magnetic layer which carried out antiferromagnetism combination changes with the thickness of a bias antiferromagnetism film. Namely, the property that the joint magnetic field will be saturated if a joint magnetic field becomes large and becomes the above thickness to some extent so that the thickness of a bias antiferromagnetism film is large is used. By forming the bias antiferromagnetism film which has a level difference by the thickness difference on a free magnetic layer Although the free magnetic layer which is in contact with the big portion of thickness on either side is combined by the very strong joint magnetic field, and the free magnetic layer is [ near the head truck section ] in contact with the small bias antiferromagnetism film of thickness on the other hand and it is combined by the comparatively small joint magnetic field The direction of the magnetization will be turned to in the same direction as the big bias antiferromagnetism film of thickness, and the direction of the magnetization of a free magnetic layer which has the strong joint magnetic field. The direction of the magnetization stabilized very much will be obtained, and the magnetoresistance-effect type thin film head of high reproducibility ability with high reproduction sensitivity with few noises can be produced. moreover, since there is no influence which is not concerned with gap length, but has the same effect, and this bias magnetic field has on a fixed magnetic layer in order to apply a bias magnetic field by the joint magnetic field with a bias antiferromagnetism film and the inclination of magnetization of the fixed magnetic layer by it is not produced, either, the magnetoresistance-effect type thin film head by which degradation of the symmetric property of an output wave was suppressed is producible
[0045] In addition, by forming a cap layer, oxidization of the portion which the bias antiferromagnetism film exposed can be prevented, and corrosion resistance can be raised.
[0046] Moreover, as for each heat treatment (annealing processing) to the antiferromagnetism layer or bias antiferromagnetism film which adds the direction of magnetization to each of a fixed magnetic layer or a free magnetic layer, it is good to carry out, after a cap layer is formed, and before patterning of a cap layer, an electrode lead layer, and the bias antiferromagnetism film is carried out to a predetermined configuration and they are shaved off. Moreover, the heat treatment conditions of the bias antiferromagnetism film for adding the direction of magnetization to the heat treatment conditions and free magnetic layer of an antiferromagnetism layer for setting the direction of magnetization as a fixed magnetic layer must select each material of an antiferromagnetism layer and a bias antiferromagnetism film so that at least one conditions of magnetic field strength, heat treatment temperature, and heat treatment time may differ.
[0047] In addition, by forming a laminating fixed magnetic layer, the leakage magnetic field by the end-face magnetic charge of the fixed magnetic layer by which the direction of magnetization was strongly fixed in the predetermined direction will be negated by the fixed magnetic layer film formed through the non-magnetic layer film, and an effect is to stop a noise.
[0048] (Gestalt 3 of operation) Drawing 12 - drawing 16 are outline explanatory drawings showing the gestalt 3 of operation of this invention, are process outline explanatory drawing for explaining the manufacturing process of the magnetoresistance-effect type thin film magnetic head for reproduction, and are the outline cross section which made it the cross section near the head sliding surface which counters a magnetic-recording medium in respect of being parallel to a head sliding surface. Hereafter, the manufacture method of the magnetoresistance-effect type thin film magnetic head for reproduction is explained in order of each process using a drawing.
[0049] Like the form 2 of the above-mentioned operation, as the 1st process, as shown in drawing 5 (a) As material, such as IrMn, alphaFe2O3, NiO, a FeMn system alloy film, a NiMn system alloy film, or a PtMn system alloy film, is used, the antiferromagnetism layer 51 is formed on the lower gap insulating layer 42 and it is further shown in drawing 5 (b) Moreover, the fixed magnetic layer 52 is formed by being made from a NiFe system alloy film, Co, or a CoFe alloy film. Next, as shown in drawing 5 (c), the non-magnetic layer 53 made from Cu etc. is formed on the fixed magnetic layer 52. Furthermore, as shown in drawing 5 (d), on a non-magnetic layer 53, the free magnetic layer 54 is formed using the same material as the fixed magnetic layer 52, and the GMR element 55 by which laminating membrane formation of the

antiferromagnetism layer 51, the fixed magnetic layer 52, a non-magnetic layer 53, and the free magnetic layer 54 was carried out one by one by the thin film is formed.
[0050] The 1st bias antiferromagnetism film 121 is formed using the antiferromagnetism material (however, it is better not to use metal oxide material, such as alphaFe2O3 and NiO, depending on the case) of different species [ layer / antiferromagnetism / 51 / which constitutes the GMR element 55 on the GMR element 55 as shown in drawing 12 (a) as the 2nd process ]. The type resist 122 is formed. next, it is shown in drawing 12 (b) -- as -- a mushroom -- On the 1st bias antiferromagnetism film 121, membrane formation formation of the 2nd bias antiferromagnetism film 123 of a right-and-left couple is carried out using the same antiferromagnetism material as the 1st bias antiferromagnetism film 121. It has the 1st flat surface 124 which is the upper surface of the 1st bias antiferromagnetism film 121, and the 2nd flat surface 125 which is the upper surface of the 2nd bias antiferromagnetism film 123 formed on the 1st bias antiferromagnetism film 121. In the 1st flat-surface section, the thickness is the thickness of the 1st bias antiferromagnetism film 121 itself. In the 2nd flat-surface section, it is the sum of each thickness of the 1st bias antiferromagnetism film 121 and the 2nd bias antiferromagnetism film 123, and the bias antiferromagnetism film 126 which has a level difference by the thickness difference can be formed. Here, the material of the 1st bias antiferromagnetism film 121 and the 2nd bias antiferromagnetism film 123 must be chosen so that it may differ in the heat treatment conditions of the antiferromagnetism layer 51 for the heat treatment conditions (the magnetic field strength, heat treatment temperature, and heat treatment time to add) for adding the direction of magnetization to the free magnetic layer 54 adding the direction of magnetization to the fixed magnetic layer 52, and at least one condition. Moreover, the material of the 1st bias antiferromagnetism film 121 and the 2nd bias antiferromagnetism film 123 may be an antiferromagnetism material of a different kind, as long as a joint magnetic field with a free magnetic layer becomes large by forming the 2nd antiferromagnetism film 123, and it is necessary at this time to heat-treat on the conditions suitable for the 1st bias antiferromagnetism film 121 and the 2nd bias antiferromagnetism film 123.
[0051] as the 3rd process, it is shown in drawing 13 -- as -- a mushroom -- using the type resist 122, on the 2nd bias antiferromagnetism film 123 of a right-and-left couple, non-magnetic materials, such as Cu, Cr, or Ta, are used, and membrane formation formation of the electrode lead layer 131 of a right-and-left couple is carried out
[0052] As the 4th process, as shown in drawing 14 , on the portion which the electrode lead layer 131 of a right-and-left couple and the 1st bias antiferromagnetism film 121 exposed, material, such as Ta, is used and the cap layer 141 is formed.
[0053] Next, although not illustrated, carry out patterning of the cap layer 141, the electrode lead layer 131 of a right-and-left couple, and the bias antiferromagnetism film 126 to a predetermined configuration, and they are shaved off. Furthermore, on them, an up gap insulating layer is formed using the same insulating material as the lower gap insulating layer 42, further, on it, membrane formation formation of the up shield layer is carried out using the same soft magnetic materials as the lower shield layer 41, and the magnetoresistance-effect type thin film magnetic head for reproduction is produced.
[0054] In addition, it cannot be overemphasized that a laminating fixed magnetic layer or a laminating free magnetic layer can be formed, and a GMR element can be formed like other examples of the 1st process of the form 2 of the above-mentioned operation.
[0055] The type resist 122 is formed. moreover, it is shown in drawing 12 (b) as other examples of the 2nd process -- as -- a mushroom -- The upper surface of the 1st bias antiferromagnetism film 121 is cleaned by methods, such as a pulley spatter by Ar etc., or efficient consumer response. The oxide film of the front face of the 1st bias antiferromagnetism film 121, the remnants of a resist, After removing a foreign matter or dirt, the 2nd bias antiferromagnetism film 123 of a right-and-left couple by carrying out membrane formation formation on the 1st bias antiferromagnetism film 121 using the same antiferromagnetism material as the 1st bias antiferromagnetism film 121 Since there is no intervention of a foreign matter between the 1st bias antiferromagnetism film 121 and the 2nd bias antiferromagnetism film 123, and very good adhesion and a magnetic combination are stabilized and are obtained, The joint magnetic field stabilized more can be acquired without the joint magnetic field strength of a bias antiferromagnetism film and a free magnetic layer falling. .
[0056] moreover, like other examples of the 2nd process of the form 2 of the above-mentioned operation as other examples of the 2nd process When the equipment which forms the 1st bias antiferromagnetism layer membrane 61 in the 2nd process differs from the equipment which forms the GMR element 55 in the 1st process The upper surface of the free magnetic layer 54 is cleaned by methods, such as a pulley spatter by Ar etc., or efficient consumer response. It is made to be the same as that of the 2nd process shown in drawing 12 , after removing the oxide film of the front face of the free magnetic layer 54, the remnants of a resist, a foreign matter, or dirt. the cleaned free magnetic layer 54 top -- a wrap -- like -- the 1st bias antiferromagnetism film 121 -- forming membranes -- a it top -- a mushroom -- it is better to have formed the type resist 122 and to carry out membrane formation formation of the 2nd bias antiferromagnetism film 123 of a right-and-left couple The joint magnetic field stabilized more can be acquired like the form 2 of the above-mentioned operation, without the joint magnetic field strength of a bias antiferromagnetism film and a free magnetic layer falling.
[0057] moreover, the mushroom formed at the 2nd process as other examples of the 3rd process, as shown in drawing 15 (a), after deleting a type resist So that the portion top which the 2nd bias antiferromagnetism film 123 of a right-and-left couple and the 1st bias antiferromagnetism film 121 exposed may be covered As the electrode lead layer membrane 151 is formed and it is shown in drawing 15 (b), so that a part of 1st flat surface 124 of the 1st bias antiferromagnetism film 121 may be exposed A photoresist is applied, by methods, such as dry etching, a part of electrode lead layer membrane 151 may be deleted at least, and the electrode lead layer 152 of a right-and-left couple may be formed.
[0058] moreover, the mushroom formed at the 2nd process as other examples of the 3rd process -- after deleting a type resist, it is shown in drawing 16 -- as -- another mushroom on the 1st bias antiferromagnetism film 121 -- the type resist 161 may be formed and membrane formation formation of the electrode lead layer 162 of a right-and-left couple may be carried out
[0059] According to the form 3 of this operation, as mentioned above like the form 2 of the above-mentioned operation The free magnetic layer which is in contact with the big bias antiferromagnetism film of thickness carries out antiferromagnetism combination with a bias antiferromagnetism film by the very strong joint magnetic field. The direction of magnetization of the free magnetic layer which is in contact with the small bias antiferromagnetism film of thickness Will stabilize and be suitable towards the same magnetization as the fre magnetic layer which is in contact with the big bias antiferromagnetism film of thickness. On the 1st antiferromagnetism film with which the direction of

the magnetization stabilized very much was obtained, and the upper surface was cleaned, by carrying out membrane formation formation of the 2nd antiferromagnetism film between the 1st antiferromagnetism film and the 2nd antiferromagnetism film Very good adhesion and a magnetic combination are stabilized, and are obtained, and the direction of the magnetization of a free magnetic layer which has the joint magnetic field by the big antiferromagnetism film of thickness and strong antiferromagnetism combination becomes what was stabilized very much. The magnetoresistance-effect type thin film head of high reproducibility ability with high reproduction sensitivity with few noises is producible. moreover, since there is no influence which is not concerned with gap length, but has the same effect, and this bias magnetic field has on a fixed magnetic layer in order to apply a bias magnetic field by the joint magnetic field with a bias antiferromagnetism film and the inclination of magnetization of the fixed magnetic layer by it is not produced, either, the magnetoresistance-effect type thin film head by which degradation of the symmetric property of an output wave was suppressed is producible

[0060] In addition, in the form 3 of the form 2 of the above-mentioned operation - operation, after a cap layer is formed, and before patterning of a cap layer, an electrode lead layer, a bias antiferromagnetism film, and the GMR element is carried out to a predetermined configuration and they are shaved off as the 4th process, as for heat treatment which adds the direction of magnetization to a fixed magnetic layer and a free magnetic layer in the predetermined direction, respectively, it is desirable to carry out. It cannot be overemphasized by the heat treatment conditions (magnetic field strength, processing temperature, and processing time) to the antiferromagnetism layer which adds the direction of magnetization to a fixed magnetic layer here, and the heat treatment conditions to the bias antiferromagnetism film which adds the direction of magnetization to a free magnetic layer that the material of the bias antiferromagnetism film which touches the antiferromagnetism layer and free magnetic layer which touch a fixed magnetic layer, respectively must be chosen so that at least one condition items may differ.

[0061] (Form 4 of operation) Drawing 17 - drawing 20 are outline explanatory drawings showing the form 4 of operation of this invention, are process outline explanatory drawing for explaining the manufacturing process of the magnetoresistance-effect type thin film magnetic head for reproduction, and are the outline cross section which made it the cross section near the head sliding surface which counters a magnetic-recording medium in respect of being parallel to a head sliding surface. Hereafter, the manufacture method of the magnetoresistance-effect type thin film magnetic head for reproduction is explained in order of each process using a drawing.

[0062] Like the 1st process of the form 2 of the above-mentioned operation, as shown in drawing 5 , the antiferromagnetism layer 51, the fixed magnetic layer 52, a non-magnetic layer 53, and the free magnetic layer 54 form the GMR element 55 by which laminating membrane formation was carried out one by one.

[0063] As the 2nd process, as shown in drawing 17 (a), the 1st bias antiferromagnetism film 171 is formed and the cap layer 172 is further formed on it so that the free magnetic layer 54 top at the topmost part of the GMR element 55 may be covered. next, it is shown in drawing 17 (b) -- as -- the cap layer 172 top -- a mushroom -- the type resist 173 is formed, as the cap layer 172 is shaved off and it is shown in drawing 17 (c), on it, membrane formation formation of the 2nd bias antiferromagnetism film 174 of a right-and-left couple is carried out, and the antiferromagnetism film 175 which has the level difference from which thickness differs is formed, so that the front face of the 1st bias antiferromagnetism film 171 may be exposed to right and left

[0064] as the 3rd process, it is shown in drawing 18 -- as -- a mushroom -- using the type resist 173, on the 2nd bias antiferromagnetism film 174 of a right-and-left couple, non-magnetic materials, such as Cu, Cr, or Ta, are used, and membrane formation formation of the electrode lead layer 181 of a right-and-left couple is carried out

[0065] The process after it is the same as the form 2 of the above-mentioned operation.

[0066] In addition, it cannot be overemphasized like other examples of the 1st process of the form 2 of the above-mentioned operation that a laminating fixed magnetic layer or a laminating free magnetic layer may be formed.

[0067] moreover, like other examples of the 2nd process of the form 3 of the above-mentioned operation as other examples of the 2nd process it is shown in drawing 17 (b) -- as -- the cap layer 172 top -- a mushroom -- so that the type resist 173 may be formed and the front face of the 1st bias antiferromagnetism film 171 may be exposed to right and left In shaving off the cap layer 172 and carrying out membrane formation formation of the 2nd bias anti-******** using another equipment The upper surface of the 1st exposed bias antiferromagnetism film 171 is cleaned by methods, such as a pulley spatter by Ar etc., or efficient consumer response. After removing the oxide film of the front face of the 1st bias antiferromagnetism film 171, the remnants of a resist, a foreign matter, or dirt, membrane formation formation of the 2nd bias antiferromagnetism film 174 of a right-and-left couple is carried out on the 1st bias antiferromagnetism film 171. It is more desirable to form the antiferromagnetism film 175 which has the level difference from which thickness differs. On the 1st antiferromagnetism film with which the upper surface was cleaned, very good adhesion and a magnetic combination are stabilized, and are obtained between the 1st antiferromagnetism film and the 2nd antiferromagnetism film by carrying out membrane formation formation of the 2nd antiferromagnetism film, and the direction of the magnetization of a free magnetic layer which has the joint magnetic field by the big antiferromagnetism film of thickness and strong antiferromagnetism combination becomes what was stabilized very much.

[0068] Moreover, when the equipment which forms the 1st bias antiferromagnetism layer membrane 171 in the 2nd proc ss differs from the equipment which forms the GMR element 55 in the 1st process Like other examples of the 2nd process of the form 3 of the above-mentioned operation as other examples of the 2nd process The upper surface of the free magnetic layer 54 is cleaned by methods, such as a pulley spatter by Ar etc., or efficient consumer response. It is made to be the same as that of the 2nd process shown in drawing 17 , after removing the oxide film of the front face of the free magnetic layer 54, the remnants of a resist, a foreign matter, or dirt. the cleaned free magnetic layer 54 top -- a wrap -- like -- the 1st bias antiferromagnetism film 171 -- forming membranes -- further -- a it top -- the cap layer 172 -- forming membranes -- a it top -- a mushroom -- it is better to have formed the type resist 173 and to carry out membrane formation formation of the 2nd bias antiferromagnetism film 174 of a right-and-left couple There is no intervention of a foreign matter between the free magnetic layer 54 and the 1st bias antiferromagnetism film 171 by cleaning the upper surface of the free magnetic layer 54 at this time, and the joint magnetic field stabilized more can be acquired, without the joint magnetic field strength of a bias antiferromagnetism film and a free magnetic layer falling, since very good adhesion and a magnetic combination are stabilized and are obtained.

[0069] moreover, the mushroom formed at the 2nd process as other examples of the 3rd process, as shown in drawing 19 , after deleting a type resist So that the exposed 2nd bias antiferromagnetism film 174 and cap layer 172 top may be covered A photoresist may be applied, the electrode lead layer membrane 191 may be shaved off by methods, such as dry etching, and the electrode lead layer 192 of a right-and-left couple may be formed so that the electrode lead layer membrane 191 may be formed and a part of cap layer 172 may be exposed after that. Moreover, after shaving off an

electrode lead layer, it is also possible to choose the material of the cap layer 172 so that the bias antiferromagnetism film 171 may not be shaved.
[0070] moreover, the mushroom formed at the 2nd process as other examples of the 3rd process -- after deleting a type resist, it is shown in drawing 20 -- as -- another mushroom on the cap layer 172 -- the type resist 201 may be formed and the electrode lead layer 202 of a right-and-left couple may be formed
[0071] In addition, as for each heat treatment to the antiferromagnetism layer and bias antiferromagnetism film for adding the direction of magnetization in a predetermined direction to a fixed magnetic layer and a free magnetic layer, respectively, it is desirable to carry out, after a cap layer is formed, and before patterning of a bias antiferromagnetism film and the GMR element is carried out to a predetermined configuration and they are shaved off. It cannot be overemphasized by the heat treatment conditions (a magnetic field, processing temperature, and processing time) to the antiferromagnetism layer for adding the direction of magnetization to a fixed magnetic layer here, and the heat treatment conditions to the bias antiferromagnetism film for adding the direction of magnetization to a free magnetic layer that the material of the bias antiferromagnetism film which touches the antiferromagnetism layer and free magnetic layer which touch a fixed magnetic layer, respectively must be chosen so that at least one condition items may differ.
[0072] According to the form 4 of this operation, as mentioned above by very strong antiferromagnetism combination of the free magnetic layer which is in contact with the big bias antiferromagnetism film of thickness like the form 2 of the above-mentioned above-mentioned operation, and the form 3 of operation The direction of magnetization of the free magnetic layer which is in contact with the small bias antiferromagnetism film of thickness It becomes a bird clapper that it is easy to be suitable towards the same magnetization as the free magnetic layer which is in contact with the big bias antiferromagnetism film of thickness. On the 1st antiferromagnetism film with which the direction of the magnetization stabilized very much was obtained, and the upper surface was cleaned, by carrying out membrane formation formation of the 2nd antiferromagnetism film between the 1st antiferromagnetism film and the 2nd antiferromagnetism film Very good adhesion and a magnetic combination are stabilized, and are obtained, and the direction of the magnetization of a free magnetic layer which has the joint magnetic field by the big antiferromagnetism film of thickness and strong antiferromagnetism combination becomes what was stabilized very much. Moreover, since time for a bias antiferromagnetism film to be exposed by preparing a cap layer on the 1st antiferromagnetism film by this manufacture method is sharply reducible, Property degradation of a bias antiferromagnetism film can be suppressed and the magnetoresistance-effect type thin film head of the outstanding reproducibility ability with high reproduction sensitivity with few Barkhausen noises can be produced.
[0073]
[Effect of the Invention] The joint magnetic field of the soft-magnetism film with which this invention is in contact with the antiferromagnetism film as mentioned above The property of carrying out abbreviation saturation if it will become large if the thickness of an antiferromagnetism film is large, and it becomes beyond a certain range is used. By preparing the bias antiferromagnetism film which has a level difference so that thickness may be small and thickness may become [ except near the head truck ] large on the free magnetic layer of a GMR element near the portion which constitutes a head truck The portion of the free magnetic layer which is in contact with the bias antiferromagnetism film of the big portion of thickness Carry out antiferromagnetism combination with a bias antiferromagnetism film, and it is combined by the very strong joint magnetic field. The free magnetic layer of the portion which the direction of the magnetization became what was stabilized very much, therefore is in contact with the bias antiferromagnetism film of the small portion of thickness also by the small joint magnetic field The direction of the magnetization which was easy to turn to in the same direction as the magnetization direction of the portion of the free magnetic layer which was stabilized and is in contact with the large bias antiferromagnetism film of thickness, and was stabilized is obtained. Moreover, since the antiferromagnetism joint magnetic field of the portion of the free magnetic layer which is in contact with the antiferromagnetism film of the small portion of thickness is small, The direction of magnetization becomes easy to change with the magnetic fields from a magnetic-recording medium, and the effect that reproducibility ability, like a Barkhausen noise is small and reproduction sensitivity is high can be improved is not concerned with reproduction gap length, but it is ******. Moreover, it has the effect that the magnetoresistance-effect type thin film magnetic head which has such outstanding reproducibility ability is producible.

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[Translation done.]

## DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The transverse-plane outline diagram of the thin film magnetic head showing the gestalt 1 of operation of this invention
[Drawing 2] Some transverse-plane outline diagrams of the thin film magnetic head showing other examples of the gestalt 1 of operation of this invention
[Drawing 3] The graph which shows the relation between the layer joint magnetic field strength added to the free magnetic layer for explaining the gestalt 1 of operation of this invention, and a reproduction output
[Drawing 4] Outline explanatory drawing showing some processes of the manufacturing process explaining the gestalt 2 of operation of this invention of the thin film magnetic head
[Drawing 5] Outline explanatory drawing showing the 1st process in the gestalt 2 of operation of this invention
[Drawing 6] Outline explanatory drawing showing the 2nd process in the gestalt 2 of operation of this invention
[Drawing 7] Outline explanatory drawing showing the 3rd process in the gestalt 2 of operation of this invention
[Drawing 8] Outline explanatory drawing showing the 4th process in the gestalt 2 of operation of this invention
[Drawing 9] Outline explanatory drawing showing other examples of the 1st process in the gestalt 2 of operation of this invention
[Drawing 10] Outline explanatory drawing showing other examples of the 3rd process in the gestalt 2 of operation of this invention
[Drawing 11] Outline explanatory drawing showing other examples of the 3rd process in the gestalt 2 of operation of this invention
[Drawing 12] Outline explanatory drawing showing the 2nd process in the gestalt 3 of operation of this invention
[Drawing 13] Outline explanatory drawing showing the 3rd process in the gestalt 3 of operation of this invention
[Drawing 14] Outline explanatory drawing showing the 4th process in the gestalt 3 of operation of this invention
[Drawing 15] Outline explanatory drawing showing other examples of the 3rd process in the gestalt 3 of operation of this invention
[Drawing 16] Outline explanatory drawing showing other examples of the 3rd process in the gestalt 3 of operation of this invention
[Drawing 17] Outline explanatory drawing showing the 2nd process in the gestalt 4 of operation of this invention
[Drawing 18] Outline explanatory drawing showing the 3rd process in the gestalt 4 of operation of this invention
[Drawing 19] Outline explanatory drawing showing other examples of the 3rd process in the gestalt 4 of operation of this invention
[Drawing 20] Outline explanatory drawing showing other examples of the 3rd process in the gestalt 4 of operation of this invention
[Drawing 21] The tropia schematic diagram showing the conventional thin film magnetic head
[Drawing 22] The transverse-plane outline diagram showing the conventional thin film magnetic head
[Description of Notations]
1 51,224 Antiferromagnetism layer
2 52,225 Fixed magnetic layer
3 53,226 Non-magnetic layer
4 54,227 Free magnetic layer
5, 55, 92, 94,213 Magnetoresistance-effect element (GMR element)
6 62,112,124 The 1st flat surface
7 63,113,125 The 2nd flat surface
8 64,114,126,175 Bias antiferromagnetism film
9, 72, 102, 115, 131, 152, 162, 181, 192, 202, 215 Electrode lead layer
10 81,141,172,228 Cap layer
40 Substrate
41,211 Lower shield layer
42,212 Lower gap insulating layer
61 Bias Antiferromagnetism Layer Membrane
71,111,151,191 Electrode lead layer membrane
91 Laminating Fixed Magnetic Layer
93 Laminating Free Magnetic Layer
101, 122, 161, 163, and 201 a mushroom — type resist
121 171 1st bias antiferromagnetism film
123 174 2nd bias antiferromagnetism film
214 Vertical Bias Layer
216 Up Gap Insulating Layer
217 Up Shield Layer
218 Magnetoresistance-Effect Type Thin Film Magnetic Head for Reproduction
220 Induction-Type Thin Film Magnetic Head for Record
221 Record Gap Layer
222 Up Magnetic Pole
223 Coil Coil

229 Reproduction Head Gap Length
901 1st Fixed Magnetic Layer Film
902 1st Non-magnetic Layer Film
903 2nd Fixed Magnetic Layer Film
911 1st Free Magnetic Layer Film
912 2nd Free Magnetic Layer Film
913 N-th Free Magnetic Layer Film

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[Translation done.]